REMARKS

Applicant has carefully reviewed the Office Action mailed November 1, 2006 and offers the following remarks to accompany the above amendments.

Claims 1, 10, and 19 have been amended to remove limitations not necessary for patentability and to return the claims to the form in which they were originally filed. Claims 28-30 have been added. These claims correspond to originally filed claims 6, 15, and 24.

Claims 1-5, 7-14, 16-23 and 25-27 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,718,500 B1 to Lee et al. (hereinafter "Lee") or, in the alternative, under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of U.S. Patent No. 6,895,010 B1 to Chang et al. (hereinafter "Chang"). Applicant respectfully traverses. For a reference to be anticipatory, the reference must disclose each and every claim element. Further, the elements of the reference must be arranged as claimed. MPEP § 2131. The requirement that each and every element be disclosed in the manner claimed is a rigorous standard that the Patent Office has not met in this case.

Claim 1 recites a method for initiating retransmission of frames comprising:

a) detecting a failed attempt to transmit a frame at a physical layer of a receiver;

b) sending a message from the physical layer of the receiver to a link control layer of the receiver to indicate the failed attempt to transmit a frame has been detected; and

c) upon receipt of the message, sending a retransmission message from the link control layer of the receiver, the retransmission message configured to cause a sender to retransmit data associated with the frame.

Lee does not teach or suggest each and every element of claim 1. In particular, Lee does not teach or suggest the limitation of "upon receipt of the message, sending a retransmission message from the link control layer of the receiver. . .." The message in question is the message from the physical layer of the receiver to a link control layer of the receiver (see element b of claim 1). In the claimed invention, upon receipt of the message at the link control layer of the receiver from the physical layer, the link control layer of the receiver sends a retransmission message. The Patent Office opines that this claim element is taught or suggested by Lee at col. 3, lines 4-27 (Office Action mailed November 1, 2006, pp. 3-4). Applicant respectfully traverses this assertion.

The cited passage of Lee does not teach or suggest that a message is sent from the physical layer of the receiver to a link control layer of the receiver and that upon receipt of that message, the link control layer of the receiver sends a retransmission message. Column 3, lines 4-27 of Lee discloses a RLP communication device and method for controlling the transmission of frames. There is no discussion of receiving a message at the link control layer of the receiver and then sending a retransmission message from the link control layer of the receiver. Column 3, lines 13-17 discusses transmitting a frame with control information using an ARQ function to verify whether or not every frame has been correctly transmitted, but there is no discussion of receiving and sending messages at the link control layer of the receiver. Likewise, column 3, lines 21-27 of Lee mentions the RLP layer transferring an information frame including information about a transmission side to a physical/multiplexing layer at set periods when there is no data to transmit. However, there is no indication in that passage that the information frame is sent from the link control layer of the receiver, as required by the claims. Thus, the information frame cannot be the claimed retransmission message. In fact, there is no mention in column 3, lines 4-27 of Lee that a message is sent from the physical layer of the receiver to a link control layer of the receiver and that upon receipt of that message, the link control layer of the receiver sends a retransmission message, as required by claim 1. Column 2, lines 53-56 does state that the "physical layer of a receiving side informs a radio link protocol that no physical frame has been received." However, there is no indication of what is done after the physical layer informs the radio link protocol that the frame has not been received. Certainly, there is no teaching that upon receipt of the message, a retransmission message is sent from the link control layer of the receiver, as recited in claim 1.

A reading of the Lee patent shows that the majority of the patent is focused on the transmit side and does not mention much of what happens at the receiver. Thus, it is not surprising that Lee does not disclose sending a message from the physical layer of the receiver to a link control layer of the receiver and that upon receipt of that message, the link control layer of the receiver sends a retransmission message. The only disclosure of the receiving side that Applicant has located starts at column 9, line 19 of Lee. While not specifically cited by the Patent Office, Applicant notes that Lee does state that the "physical channel/multiplexing device transfers an erasure frame to the radio link protocol when a received physical channel frame is in a bad condition." (Lee, col. 9, lines 29-32). Lee further states that the radio link protocol

operates as defined in RLP Type 2 with regard to the erasure frame (Lee, col. 9, lines 36-39). However, Applicant obtained and reviewed the RLP Type 2, attached as Appendix A. Applicant's study of this RLP Type 2 standard did not find that a retransmission request is generated on receipt of the erasure frame. The RLP Type 2 standard does not increase the NAK counter when an erasure frame is received. Instead, the RLP maintains a count of the number of consecutive frames classified as erasure frames and when it exceeds 255, the RLP performs an initialization/reset procedure. Notably, the erasure frame does not cause a retransmission request to be sent from the link control layer of the receiver to cause a sender to retransmit data associated with the frame, as required by claim 1. Therefore, Lee does not show the claim element recited in claim 1. Since Lee does not show the claim element, Lee cannot anticipate claim 1. Claims 2-5 and 7-9 depend from claim 1 and are not anticipated for at least the same reasons. Applicant requests withdrawal of the § 102(e) rejection of claims 1-5 and 7-9 on this basis.

Independent claims 10 and 19 recite similar elements and are not anticipated for at least the same reasons. Dependent claims 2-5, 7-9, 11-14, 16-18, 20-23, and 25-30 depend directly or indirectly from one of the independent claims and further define patentable subject matter. Thus, these dependent claims are patentable for at least the same reasons set forth above with respect to claim 1.

Claims 1-5, 7-14, 16-23 and 25-27 were rejected in the alternative under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Chang. Applicant respectfully traverses. For the Patent Office to combine references in an obviousness rejection, the Patent Office must prove a suggestion to combine the references. To prove that there is a suggestion to combine the references, the Patent Office must do two things. First, the Patent Office must state a motivation to combine the references, and second, the Patent Office must support the stated motivation with actual evidence. *In re Dembiczak*, 175 F.3d 994, 999 (Fed. Cir. 1999). Even if the combination of references is proper, to establish *prima facie* obviousness, the combination must still teach or suggest all the claim elements. MPEP § 2143.03.

The combination of Lee and Chang fails to establish obviousness because the combination does not teach or suggest all the claim elements. As explained above, claim 1 recites "upon receipt of the message, sending a retransmission message from the link control layer of the receiver. . ." and this element is not taught or suggested by Lee. Nothing in Chang

cures the deficiencies of Lee. Since the references individually do not teach or suggest this element, the combination of references cannot teach or suggest this claim element. Since the combination does not teach or suggest this claim element, the combination does not establish obviousness. Since the combination does not establish obviousness, the claims are allowable.

Independent claims 10 and 19 recite similar elements and are not obvious for at least the same reasons. Dependent claims 2-5, 7-9, 11-14, 16-18, 20-23, and 25-30 depend directly or indirectly from one of the independent claims and further define patentable subject matter. Thus, these dependent claims are patentable for at least the same reasons set forth above.

Applicant requests reconsideration of the rejections in light of the remarks presented herein. The references do not teach or suggest that upon receipt of the message sent from the physical layer of the receiver to the link control layer of the receiver, sending a retransmission message from the link control layer of the receiver, as recited in the claims. Applicant earnestly solicits claim allowance at the Examiner's earliest convenience. The Examiner is encouraged to contact Applicant's representative regarding any remaining issues in an effort to expedite allowance and issuance of the present application.

Respectfully submitted,
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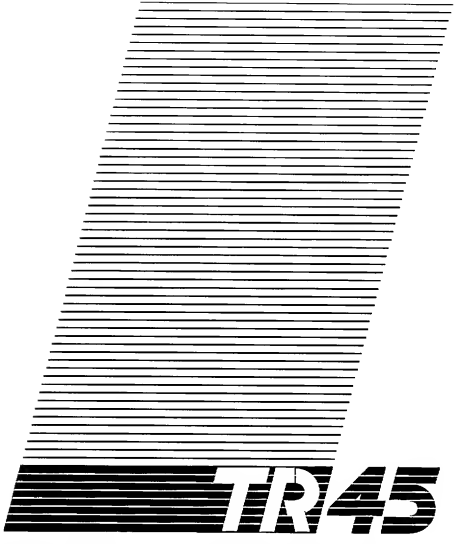
Appendix A



Data Service Options for Spread Spectrum Systems: Radio Link Protocol Type 2

TIA/EIA/IS-707-A.8 (PN-4145.8)

Ballot Resolution Version

March, 1999

CONTENTS

CONTENTS

FIGURES

TABLES

1 INTRODUCTION

1.1 General Description

This chapter specifies procedures for Radio Link Protocol Type 2, which is used with a TIA/EIA-95-B Traffic Channel to support CDMA data services. For the remainder of this chapter, Radio Link Protocol Type 2 shall be called RLP.

RLP provides an octet stream transport service over forward and reverse traffic channels. RLP is unaware of higher layer framing; it operates on a featureless octet stream, delivering the octets in the order received.

RLP has procedures to substantially reduce the error rate exhibited by CDMA traffic channels. There is no direct relationship between higher layer packets and the underlying traffic channel frames; a large packet may span multiple traffic channel frames, or a single traffic channel frame may contain all or part of several small higher layer packets.

Section 2 below is a general description of RLP that defines its use by any service option for which it is suited. Section 3 defines the RLP procedures for encrypted or non-encrypted applications. Section 4 defines the RLP frame formats.

1.2 Terms

Base Station (BS). A station in the Domestic Public Cellular Radio Telecommunications Service, other than a mobile station, used for communicating with mobile stations. Depending upon the context, the term base station may refer to a cell, a sector within a cell, or other part of the cellular system.

BS. See base station.

BS/MSC. The base station and mobile switching center considered as a single functional entity.

Data Block. A unit of data transmitted by the mobile/base station, used to transport user data and signaling traffic. For Multiplex Options 1 and 2, one data block is transmitted by the mobile/base station every 20 ms. For Multiplex Options 2n - 1, n = 2 through 8, at least one data block and at most n data blocks are transmitted by the mobile/base station every 20 ms. For Multiplex Options 2n, n = 2 through 8, at least one data block and at most n data blocks are transmitted by the mobile/base station every 20 ms.

Forward Fundamental Code Channel. A Fundamental Code Channel operating in the forward direction.

Forward Supplemental Code Channel. A Supplemental Code Channel operating in the forward direction.

Forward Traffic Channel. One Forward Fundamental Code Channel and optionally up to seven Forward Supplemental Code Channels used to transport data blocks from the base station to the mobile station.

Fundamental Code Channel. A portion of a Traffic Channel (Forward or Reverse) that is always present, and carries a fundamental data block and power control information.

Fundamental Data Block. A data block that is transmitted on the Fundamental Code Channel. It may contain signaling traffic, primary traffic, and secondary traffic.

Fundamental RLP Frame. An RLP frame carried in a fundamental data block.

Mobile Station. A station in the Domestic Public Cellular Radio Telecommunications Service intended to be used while in motion or during halts at unspecified points. Mobile stations include portable units (e.g., hand-held personal units) and units installed in vehicles.

MSC. Mobile Switching Center.

NAK List. A list maintained by RLP to associate the 12-bit sequence number of a missing data frame with the 8-bit sequence number contained in the retransmitted data frame.

Reverse Fundamental Code Channel. A Fundamental Code Channel operating in the reverse direction.

Reverse Supplemental Code Channel. A Supplemental Code Channel operating in the reverse direction.

Reverse Traffic Channel. One Reverse Fundamental Code Channel and optionally up to seven Reverse Supplemental Code Channels used to transport data blocks from the mobile station to the base station.

RLP. Radio Link Protocol.

Supplemental Code Channel. A portion of a Traffic Channel (Forward or Reverse) that is optionally present and carries a supplemental data block.

Supplemental Data Block. A data block that is transmitted on a Supplemental Code Channel. It may contain only primary traffic or secondary traffic.

Supplemental RLP Frame. An RLP frame carried in a supplemental data block.

1.3 References

TIA/EIA-95-B	*Mobile Station-Base Station Compatibility Standard for Dual-Mode Spread Spectrum System, August, 1998.*
TSB58	*Administration of Parameter Value Assignments for TIA/EIA Wideband Spread Spectrum Standards, December, 1995.*

2 GENERAL REQUIREMENTS

2.1 Required Multiplex Option Support

Mobile stations supporting RLP shall send and receive traffic channel frames in accordance with the requirements of TIA/EIA-95-B Multiplex Options 1 through 16.

Mobile stations supporting multiple connected service options may support independent instances of RLP for each service option, but each traffic type shall carry only a single instance of RLP.

Non-blank RLP frames may be carried by the following Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15 traffic channel frames when sent in a fundamental data block:

- 9600 bps primary traffic only
- 4800 bps primary traffic only
- 1200 bps primary traffic only
- Dim and Burst with Rate 1/2 primary and signaling traffic, as primary traffic
- Dim and Burst with Rate 1/2 primary and secondary traffic, as either primary traffic, secondary traffic, or both[1]
- Dim and Burst with Rate 1/4 primary and secondary traffic, as secondary traffic
- Dim and Burst with Rate 1/8 primary and signaling traffic, as primary traffic
- Dim and Burst with Rate 1/8 primary and secondary traffic, as either primary traffic, secondary traffic, or both[1]
- Blank and Burst with secondary traffic only

Non-blank RLP frames may be carried by the following Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15 traffic channel frames when sent in a supplemental data block:

- 9600 bps primary traffic only
- Blank and Burst with secondary traffic only

Non-blank RLP frames may be carried by the following Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16 traffic channel frames when sent in a fundamental data block:

- 14400 bps primary traffic only
- 7200 bps primary traffic only
- 3600 bps primary traffic only
- 1800 bps primary traffic only
- Dim and Burst with Rate 1/2 primary and signaling traffic, as primary traffic

[1] RLP may be carried as both primary and secondary traffic when there are multiple connected service options, each having its own RLP instance.

- Dim and Burst with Rate 1/2 primary and secondary traffic, as either primary traffic, secondary traffic, or both[2]
- Dim and Burst with Rate 1/4 primary and signaling traffic, as primary traffic
- Dim and Burst with Rate 1/4 primary and secondary traffic, as either primary traffic, secondary traffic, or both[2]
- Dim and Burst with Rate 1/8 primary and signaling traffic, as primary traffic
- Dim and Burst with Rate 1/8 primary and secondary traffic, as either primary traffic, secondary traffic, or both[2]
- Dim and Burst with Rate 1/8 primary, secondary, and signaling traffic, as either primary traffic, secondary traffic, or both[2]
- Blank and Burst with secondary traffic only

Non-blank RLP frames may be carried by the following Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16 traffic channel frames when sent in a supplemental data block:

- 14400 bps primary traffic only
- Blank and Burst with secondary traffic only

2.2 Fundamental Channel Rate Control

The following requirements for Fundamental Channel rate control shall apply to mobile stations having a single connected service option. Fundamental Channel rate control for mobile stations having multiple connected service options is for further study.

2.2.1 Service Negotiation Rate Control Procedures

If service negotiation is used, the BS/MSC may send a *Service Option Control Message* to the mobile station (see 7.7.3.3.2.21 of TIA/EIA-95-B). The mobile station shall not send a *Service Option Control Message* to the BS/MSC.

2.2.1.1 Mobile Station Requirements

The mobile station shall support one pending rate control *Service Option Control Message* for the service option.

If the mobile station receives a *Service Option Control Message* for the service option with FIELD_TYPE set to '000', then at the action time associated with the message, the mobile station shall process the message as follows:

- If the RATE_REDUC field is equal to a value defined in Table 3, the service option shall generate the fraction of those frames normally generated as Rate 1 frames at either Rate 1 or Rate 1/2 as specified by the corresponding line in Table 3. The

[2] RLP may be carried as both primary and secondary traffic when there are multiple connected service options, each having its own RLP instance.

service option shall continue to use these fractions until either of the following events occur:

- The mobile station receives a *Service Option Control Message* with FIELD_TYPE set to '000' specifying a different RATE_REDUC, or
- The service option is re-initialized.

- If the RATE_REDUC field is not equal to a value defined in Table 1, the mobile station shall reject the message by sending a *Mobile Station Reject Order* with the ORDQ field set equal to '00000100'.

The service option may use the following procedure to perform rate reduction. Sequences of N frames are formed as shown in Table 1 are allowed to be at Rate 1, the next N-L frames are forced to be Rate 1/2. Whenever RLP voluntarily generates a Rate 1/2 RLP data frame, the sequence shall be reset. This ensures that the first Fundamental Channel frame in a burst of data will be at Rate 1, unless RATE_REDUC equals '100' or RLP has been commanded by the multiplex sublayer to generate other than a Rate 1 frame.

Table 1 Sequence Parameters for Rate Reduction

RATE_REDUC (binary)	Sequence Length, N	Maximum Number of Contiguous Rate 1 Fundamental Frames in a Sequence, L	Number of Contiguous Rate 1/2 Fundamental Frames in a Sequence, N-L
'000'	1	1	0
'001'	4	3	1
'010'	2	1	1
'011'	4	1	3
'100'	1	0	1

2.2.1.2 BS/MSC Requirements

The BS/MSC may send a *Service Option Control Message* to the mobile station for Fundamental Channel rate control. If the BS/MSC sends a *Service Option Control Message* for Fundamental Channel rate control, the BS/MSC shall include the type-specific fields shown in Table 2.

Table 2 Service Option Control Message Type-Specific Fields for Fundamental Channel Rate Control

Field	Length (bits)
RATE_REDUC	3
RESERVED	2
FIELD_TYPE	3

RATE_REDUC - Rate reduction.

The BS/MSC shall set this field to the RATE_REDUC value from Table 3 corresponding to the rate reduction that the mobile station is to perform.

RESERVED - Reserved bits.

The BS/MSC shall set this field to '00'.

FIELD_TYPE - Type-specific field designator.

The BS/MSC shall set this field to '000'.

Table 3 Fraction of Frames at Rate 1 and Rate 1/2 with Rate Reduction

RATE_REDUC (binary)	Fraction of Normally Rate 1 Fundamental Frames to be Rate 1	Fraction of Normally Rate 1 Fundamental Frames to be Rate 1/2
'000'	1	0
'001'	3/4	1/4
'010'	1/2	1/2
'011'	1/4	3/4
'100'	0	1
All other RATE_REDUC values are reserved.		

2.3 Interface to Multiplex Options

RLP frames can be carried as primary or secondary traffic.

An RLP frame supplied to the multiplex sublayer to be carried in the fundamental data block is called a Fundamental RLP frame. Similarly, an RLP frame supplied to the multiplex sublayer to be carried in a supplemental data block is referred to as a Supplemental RLP frame.

2.3.1 Primary Traffic

When RLP frames are carried as primary traffic, RLP shall generate and supply (1+NUM_SUP) RLP frames containing the service option bits to the multiplex sublayer every 20 ms, where NUM_SUP indicates the number of supplemental data blocks allocated for primary traffic. Each RLP frame shall be one of the types as shown in Table 4. The number of bits supplied to the multiplex sublayer for each type of RLP frame shall also be as shown in Table 4. Unless otherwise commanded by Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15, RLP may supply a Rate 1, Rate 1/2, Rate 1/8 or Blank Fundamental RLP frame. Unless otherwise commanded by Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16, RLP may supply a Rate 1, Rate 1/2, Rate 1/4, Rate 1/8 or Blank Fundamental RLP frame. Upon command, RLP shall generate a Blank RLP frame. A Blank RLP frame contains no bits and is used for blank-and-burst transmission of signaling traffic (see 6.1.3.3 of TIA/EIA-95-B) or when RLP is unable to send a segment of a segmented data frame. Also upon command, RLP shall generate a non-blank Fundamental RLP frame with a maximum rate of Rate 1/2.

Each Supplemental RLP frame shall be either a Rate 1 or Blank RLP frame.

Table 4 Primary Traffic RLP Frame Types Supplied by RLP to the Multiplex Sublayer

RLP Frame Type	Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15 (bits per frame)	Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16 (bits per frame)	Can be supplied as a Supplemental RLP frame
Rate 1	171	266	Yes
Rate 1/2	80	124	No
Rate 1/4	Not Used	54	No
Rate 1/8	16	20	No
Blank	0	0	Yes

The multiplex sublayer in the mobile station categorizes every received traffic channel frame (see 6.2.2.2 of TIA/EIA-95-B), and supplies the frame's category and accompanying bits, if any, to RLP.[3] Table 5 lists the categories (and corresponding RLP frame types) supplied by the multiplex sublayer when RLP is carried as primary traffic by Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15. Although RLP does not generate Rate 1/4 frames, Multiplex Options 1, 3, 5, 7, 9, 11, 13, and 15 are not required to recognize this fact. RLP declares any Rate 1/4 frame received from Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15 to be an erasure. Table 6 lists the categories (and corresponding RLP frame types) supplied

Comment: Requirement specified in validity checks

[3] TIA/EIA-95-B allows one data block per traffic channel frame.

by the multiplex sublayer when RLP is carried as primary traffic by Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16.

Table 5 Primary Traffic RLP Frame Types Supplied by the Multiplex Sublayer to RLP for Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15

RLP Frame Type	Bits per Frame	Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15 Fundamental Code Channel Frame Categories	Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15 Supplemental Code Channel Frame Categories
Rate 1	171	1	1
Rate 1/2	80	2,6,11	N/A
Rate 1/4	40	3,7,12	N/A
Rate 1/8	16	4,8,13	N/A
Blank	0	5,14	2
Erasure	0	9,10	3

Table 6 Primary Traffic RLP Frame Types Supplied by the Multiplex Sublayer to RLP for Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16

RLP Frame Type	Bits per Frame	Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16 Fundamental Code Channel Frame Categories	Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16 Supplemental Code Channel Frame Categories
Rate 1	266	1	1
Rate 1/2	124	2,6,11	N/A
Rate 1/4	54	3,7,12,15,19	N/A
Rate 1/8	20	4,8,10,13,16,18,20, 22,24	N/A
Blank	0	5,9,14,17,21,23,25	2
Erasure	0	26	3

2.3.2 Secondary Traffic

When RLP frames are carried as secondary traffic, RLP shall generate and supply (1+NUM_SUP) RLP frames containing the service option bits to the multiplex sublayer

every 20 ms, where NUM_SUP indicates the number of supplemental data blocks allocated for secondary traffic. Each RLP frame shall be one of the types shown in Table 7. The number of bits supplied to the multiplex sublayer for each type of RLP frame shall also be as shown in Table 7. Upon command, RLP shall generate a Blank RLP frame. A Blank RLP frame contains no bits and is used for blank-and-burst transmission of signaling traffic (see 6.1.3.3 of TIA/EIA-95-B), when primary traffic has priority over secondary traffic and the primary traffic service option does not allow any secondary traffic, or when RLP is unable to send a segment of a segmented data frame (see 3.1.4).

Each Supplemental RLP frame shall be either a Rate 1 or Blank RLP frame.

Table 7 Secondary Traffic RLP Frame Types Supplied by RLP to the Multiplex Sublayer

RLP Frame Type	Bits per Frame for Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15	Bits per Frame for Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16	Can be supplied as a Supplemental RLP frame
Rate 1	168	262	Yes
Rate 7/8	152	242	No
Rate 3/4	128	208	No
Rate 1/2	88	138	No
Rate 7/16	Not Available	121	No
Rate 3/8	Not Available	101	No
Rate 1/4	Not Used	67	No
Rate 3/16	Not Available	52	No
Rate 1/8	Not Available	32	No
Rate 1/16	Not Available	20	No
Blank	0	0	Yes

The multiplex sublayer in the mobile station categorizes every received traffic channel frame (see 6.2.2.2 of TIA/EIA-95-B) and supplies the frame's category and accompanying bits, if any, to RLP.[4] Table 8 lists the categories (and corresponding RLP frame types) supplied by the multiplex sublayer when RLP is carried as secondary traffic using Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15. Table 9 lists the categories (and

[4] TIA/EIA-95-B allows one data block per traffic channel frame.

corresponding RLP frame types) supplied by the multiplex sublayer when RLP is carried as secondary traffic using Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16.

Table 8 Secondary Traffic RLP Frame Types Supplied by the Multiplex Sublayer to RLP for Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15

RLP Frame Type	Bits per Frame	Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15 Fundamental Code Channel Frame Categories	Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15 Supplemental Code Channel Frame Categories
Rate 1	168	14	2
Rate 7/8	152	13	N/A
Rate 3/4	128	12	N/A
Rate 1/2	88	11	N/A
Blank	0	1-8	1
Erasure	0	9, 10	3

Table 9 Secondary Traffic RLP Frame Types Supplied by the Multiplex Sublayer to RLP for Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16

RLP Frame Type	Bits per Frame	Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16 Fundamental Code Channel Frame Categories	Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16 Supplemental Code Channel Frame Categories
Rate 1	262	9	2
Rate 7/8	242	8	N/A
Rate 3/4	208	7	N/A
Rate 1/2	138	6	N/A
Rate 7/16	121	17	N/A
Rate 3/8	101	16	N/A
Rate 1/4	67	15	N/A
Rate 3/16	52	23	N/A
Rate 1/8	32	22	N/A
Rate 1/16	20	10,18,25	N/A
Blank	0	1-5,11-14,19-21,24	1
Erasure	0	26	3

2.4 Traffic Channel Frame Priorities

RLP shall classify RLP frames into three priority classes. In order of priority they are, with highest priority first:

1. RLP control frames
2. Retransmitted data frames (i.e., data frames being resent in response to received NAK control frames)
3. New data frames (i.e., data frames being sent for the first time)

When the multiplex sublayer indicates that it is ready to send RLP frames on a traffic channel, RLP shall supply it with the highest priority RLP frames available with the following exceptions:

1. A control frame shall only be supplied as a Fundamental RLP frame.
2. Identical retransmitted data frames should not be supplied in the same 20 ms time slot, but instead should be supplied in consecutive time slots, in order to reduce the likelihood that all retransmitted copies will be lost due to a burst error.

3. RLP shall not supply more than 1 Supplemental RLP new data frame (as defined in 4.2.3.1) in a 20 ms time slot.

When RLP frames are carried as primary traffic, and if no RLP frames in the above three priority classes are available, an idle frame (see 4.3) shall be supplied if a Fundamental RLP frame is needed and a Blank RLP frame shall be supplied if a Supplemental RLP frame is needed.

When RLP frames are carried as secondary traffic, and if no RLP frames in the above three priority classes are available, an idle frame (see 4.3) shall be generated and supplied if a Fundamental RLP frame is needed and the value of the round-trip frame counter is greater than zero. If a Supplemental RLP frame is needed, a Blank RLP frame shall be supplied.

Whenever RLP supplies a non-blank Fundamental frame and the value of the round-trip frame counter is greater than zero, RLP shall decrement the round-trip frame counter.

When a service option is connected that carries RLP frames as primary traffic, and there is no service option connected that uses secondary traffic, the mobile station should observe the following priorities in using the traffic channel:

1. Signaling Traffic
2. RLP frames in priority class order

When a service option is connected that carries RLP frames as secondary traffic, and a service option not using RLP is connected that uses primary traffic, the mobile station should observe the following priorities in using the traffic channel, if the primary traffic service option permits:

1. Signaling Traffic
2. RLP control frames, RLP retransmissions (RLP frames in priority classes 1 and 2), and RLP transmissions due to idle timer expiration (see 3.1.2). If the primary traffic service option permits, the multiplex sublayer should force primary traffic to no more than half rate when these RLP frames are available.
3. Primary traffic service option data
4. New data frames

When data from a service option that carries RLP frames using secondary traffic has a lower priority than data from the service option using primary traffic, the blank and burst with secondary traffic frame format (see 6.1.3.3 of TIA/EIA-95-B) shall not be used unless the primary traffic service option has no data to send.

When service options are connected that carry RLP frames as both primary and secondary traffic, the mobile station should observe the following priorities in using the traffic channel:

1. Signaling Traffic

2. RLP control frames and RLP retransmissions (RLP frames in priority classes 1 and 2) from the service option using primary traffic.

3. RLP control frames, RLP retransmissions (RLP frames in priority classes 1 and 2), and RLP transmissions due to idle timer expiration (see 3.1.2) from the service option using secondary traffic.

4. New data frames from the service option using primary traffic (RLP frames in priority class 3).

5. New data frames from the service option using secondary traffic (RLP frames in priority class 3).

3 RLP PROCEDURES

3.1 RLP Procedures

RLP provides the capability of both non-encrypted mode and encrypted mode data transport. The encryption capability is selected during RLP initialization/reset and is accomplished as a negotiation between the mobile station and the BS/MSC. In addition, a procedure for synchronizing RLP without encryption negotiation is also provided here. The two techniques are compatible with each other and therefore can co-exist in systems where encryption negotiation is supported in the infrastructure equipment, but possibly not in some of the mobile stations attempting access to the system.

3.1.1 Initialization/Reset Procedures

This standard defines two alternate RLP initialization/reset procedures. Non-Encrypted Mode initialization/reset shall be used by mobile stations and BS/MSCs that do not support RLP data frame encryption for the desired service. Encrypted Mode initialization/reset procedures shall be used by mobile stations and BS/MSCs to negotiate the use of RLP data frame encryption.

3.1.1.1 Non-Encrypted Mode RLP Initialization/Reset

RLP is established with a bi-directional handshake, after connection of the service option that uses RLP, to synchronize the connection. To establish RLP without RLP data encryption all control frames used (SYNC, ACK, and SYNC/ACK) shall indicate that RLP data encryption is not supported (see Table 1 1) and shall exclude both the EM and EXT_SEQ_M fields (see 4.1.1).

When RLP is initialized or reset, and when a SYNC control frame is received, RLP shall perform the following:

- Reset the send and receive state variables L_V(S), L_V(R), and L_V(N) (defined in 3.1.2) to zero.
- Set the round-trip frame counter to zero.
- Set the consecutive erasure count E (defined in 3.1.3) to zero.
- Clear the resequencing buffers (defined in 3.1.2).
- Disable all NAK retransmission timers and all NAK abort timers.
- Discard any data frames queued for retransmission.
- Discard any data frame being reassembled (see 3.1.4).
- Clear the NAK List (defined in 3.1.2).

When RLP is initialized or reset, it shall supply a continuous stream of SYNC control frames (see 4.1.1). When RLP receives a SYNC control frame it shall supply a SYNC/ACK control frame and set a round-trip frame counter to an implementation defined value

greater than or equal to 4[5], and shall continue supplying SYNC/ACK control frames until it receives the next non-blank valid frame which is not a SYNC control frame. When RLP receives a SYNC/ACK control frame it shall supply an ACK control frame and set a round-trip frame counter to an implementation defined value greater than or equal to 4, and shall continue supplying ACK control frames until it receives the next non-blank valid frame which is not a SYNC/ACK control frame. When RLP receives an ACK control frame, it shall not supply SYNC, SYNC/ACK or ACK control frames, and should begin supplying data frames.

When RLP frames are carried as primary or secondary traffic, RLP shall store in RLP_DELAY_8 the number of Fundamental RLP frames received between supplying the last SYNC or SYNC/ACK control frame and receiving the first non-blank valid frame that is not an ACK or SYNC/ACK control frame. RLP_DELAY_8 is used in NAK retransmission timing, as described in 3.1.2.1.

3.1.1.2 Encrypted Mode RLP Initialization/Reset

CDMA mobile stations complying with this standard may support authentication (see 6.3.12 of TIA/EIA-95-B) and may support encryption of RLP data frames using the procedures defined below. RLP data encryption shall be performed whenever wireless authentication procedures have been performed during the establishment of a CDMA Traffic Channel and RLP data encryption is negotiated (see 3.1.1.2.2).

3.1.1.2.1 Extended Data Frame Sequence Numbering

Mobile stations and BS/MSCs supporting RLP data encryption shall support the following extended data frame sequence numbering for data frames.

RLP shall maintain a 30-bit extended sequence number EXT_V(S). EXT_V(S) shall be set to zero when RLP is initialized following the establishment of a Traffic Channel. For all subsequent initializations/resets of RLP while the traffic channel remains established, RLP shall perform the following prior to supplying a SYNC or SYNC/ACK control frame whose EM field is set to '01':

- If the least significant 12 bits of EXT_V(S) are not zero, RLP shall set the least significant 12 bits of EXT_V(S) to zero, and shall increment the most significant 18 bits of EXT_V(S), modulo 2^{18}.
- If the least significant 12 bits of EXT_V(S) are zero, RLP shall not change EXT_V(S).

For each RLP frame transmitted, RLP shall set the value of L_V(S) (defined in 3.1.2) to the least significant 12 bits of EXT_V(S). EXT_V(S) shall be incremented, following the procedures for incrementing L_V(S) that are contained in 3.1.2 except that EXT_V(S) shall be incremented modulo 2^{30}.

RLP shall maintain a 30-bit extended sequence number EXT_V(R). When RLP is initialized or reset, RLP shall set the least significant 12 bits of EXT_V(R) to zero. The most

[5] A minimum of 4 frames sent following initialization/reset is believed to provide sufficient protection against frame erasures without incurring excessive overhead.

significant 18 bits of EXT_V(R) shall be set as described in 3.1.1.2.2.1 or 3.1.1.2.2.2 as appropriate.

When L_V(R) changes (see 3.1.2), RLP shall change EXT_V(R) by the same amount.[6]

3.1.1.2.2 RLP Data Encryption Negotiation

When authentication is performed during the establishment of a CDMA Traffic Channel, the mobile station and BS/MSC shall set the input parameters of the DataKey_Generation procedure defined in "Common Cryptographic Algorithms, Revision A.1" as follows:

- In the mobile station, RAND shall be set to the stored value of $RAND_S$.
- In the BS/MSC, RAND shall be set to the value of the RAND field of the *Access Parameters Message* that was used for mobile station authentication.
- The mobile station and BS/MSC shall use the value of SSD_B at the time of mobile station authentication.

The mobile station and BS/MSC shall then perform the DataKey_Generation procedure. The data encryption key (DataKey) and L table shall not change while the traffic channel is established.

Mobile stations and BS/MSCs supporting RLP data encryption shall perform negotiation of RLP data encryption using the procedures in 3.1.1.2.2.1 or 3.1.1.2.2.2, respectively.

If the EM field is not included in a received RLP control frame, RLP shall process the message as if EM were included and set to '00'. Throughout the following procedures, RLP may omit both the EM and EXT_SEQ_M fields whenever it generates a control frame in which the EM field would be set to '00'.

If the BS/MSC desires RLP data encryption, the BS/MSC may deny access to service if authentication procedures (see 6.3.12 of TIA/EIA-95-B) are not performed during Traffic Channel establishment, or if the mobile station indicates that it does not perform RLP data encryption.

3.1.1.2.2.1 Mobile Station Negotiation Procedures

To indicate that the mobile station can perform RLP data encryption, RLP shall generate a SYNC control frame whose ENCRYPTION_MODE field indicates at least one supported data encryption mode (see Table 11), whose EM field is set to '01', and whose EXT_SEQ_M field is set to the most significant bits of RLP's current value of EXT_V(S).

To indicate that the mobile station cannot perform RLP data encryption, RLP shall generate a SYNC control frame whose EM field is set to '00'.

When RLP receives a SYNC control frame, it shall perform the following:

- If the EM field of the received frame is set to '01', and RLP can perform at least one of the specified encryption modes, RLP shall set the most significant bits of

[6] That is, if the old value of L_V(R) is A and the new value of L_V(R) is B, EXT_V(R) is incremented by (4096+B-A) modulo 4096. All arithmetic operations on EXT_V(R) are modulo 2^{30}.

EXT_V(R) to the value of the EXT_SEQ_M field of the received frame. RLP shall set the ENCRYPTION_MODE field to indicate which of the specified encryption modes it supports (see Table 11), set the EM field to '01', and set the EXT_SEQ_M field to the most significant bits of RLP's current value of EXT_V(S).

- If the EM field of the received frame is set to any other value, or if RLP cannot perform at least one of the specified encryption modes, RLP shall set the most significant bits of EXT_V(R) to zero. In each SYNC/ACK control frame it then generates, RLP shall set the ENCRYPTION_MODE field to indicate which of the specified encryption modes it supports (see Table 11) and set the EM field to '00'.

When RLP receives a SYNC/ACK control frame, it shall perform the following:

- If the EM field of the received frame is set to '01', and RLP can perform the specified encryption mode, RLP shall set the most significant bits of EXT_V(R) to the value of the EXT_SEQ_M field of the received frame. In each ACK control frame it then generates, RLP shall set the ENCRYPTION_MODE field to indicate the specified encryption mode (see Table 11), set the EM field to '01', and set the EXT_SEQ_M field to the most significant bits of RLP's current value of EXT_V(S). RLP shall encrypt all generated data frames and shall decrypt all received data frames, using the specified encryption mode and following the procedures of 3.1.2.2.1 and 3.1.2.2.2.
- If the EM field of the received frame is set to '01', but RLP cannot perform the specified encryption mode, RLP shall perform the Non-Encrypted Mode RLP initialization/reset procedure (see 3.1.1.1).
- If the EM field of the received frame is set to any value other than '01', RLP shall set the most significant bits of EXT_V(R) to zero. In each ACK control frame it then generates, RLP shall set the ENCRYPTION_MODE field to indicate which of the specified encryption modes it supports (see Table 11) and set the EM field to '00'. RLP shall neither encrypt nor decrypt data frames.

When RLP receives an ACK control frame, it shall perform the following:

- If the EM field of the received frame is set to '01', and RLP can perform the specified encryption mode, RLP shall encrypt all generated data frames and shall decrypt all received data frames, using the specified encryption mode and following the procedures of 3.1.2.1 and 3.1.2.2.
- If the EM field of the received frame is set to '01', but RLP cannot perform the specified encryption mode, RLP shall perform the Non-Encrypted Mode RLP initialization/reset procedure (see 3.1.1.1).
- If the EM field of the received frame is set to any value other than '01', RLP shall neither encrypt nor decrypt data frames.

3.1.1.2.2.2 BS/MSC Negotiation Procedures

If the BS/MSC requests RLP data encryption, RLP shall generate a SYNC control frame whose ENCRYPTION_MODE field indicates at least one supported data encryption mode (see Table 11), whose EM field is set to '01', and whose EXT_SEQ_M field is set to the most

significant bits of the current value of EXT_V(S). RLP should set the ENCRYPTION_MODE field to indicate all supported data encryption modes or may set the ENCRYPTION_MODE field to indicate the desired data encryption mode.

- If the BS/MSC does not request RLP data encryption, RLP shall generate a SYNC control frame whose ENCRYPTION_MODE field indicates it does not support encryption (see Table 11) and whose EM field is set to '00'. The BS/MSC should not request RLP data encryption if encryption is provided by the Link Layer or higher layers.[7]

- When RLP receives a SYNC control frame, it shall perform the following:

- If the EM field of the received frame is set to '01', and the BS/MSC requests RLP data encryption, and RLP can perform at least one of the specified encryption modes (see Table 11), RLP shall set the most significant bits of EXT_V(R) to the value of the EXT_SEQ_M field of the received frame. In each SYNC/ACK control frame it then generates, RLP shall set the ENCRYPTION_MODE field to indicate its desired encryption mode (see Table 11), set the EM field to '01', and set the EXT_SEQ_M field to the most significant bits of the current value of EXT_V(S).

- If the EM field of the received frame is set to '01', the BS/MSC requests RLP data encryption, and RLP cannot perform at least one of the specified encryption modes, RLP shall perform the Non-Encrypted Mode RLP initialization/reset procedure (see 3.1.1.1)

- If the EM field of the received frame is set to any other value, or if the BS/MSC does not request RLP data encryption, RLP shall set the most significant bits of EXT_V(R) to zero. In each SYNC/ACK control frame it then generates, RLP shall set the ENCRYPTION_MODE field to indicate that it does not support RLP data encryption and set the EM field to '00'.

When RLP receives a SYNC/ACK control frame, it shall perform the following:

- If the EM field of the received frame is set to '01', and the BS/MSC requests RLP data encryption, and RLP can perform at least one of the specified encryption modes, RLP shall set the most significant bits of EXT_V(R) to the value of the EXT_SEQ_M field of the received frame. In each ACK control frame it then generates, RLP shall set the ENCRYPTION_MODE field to indicate its desired encryption mode, set the EM field to '01', and set the EXT_SEQ_M field to the most significant bits of RLP's current value of EXT_V(S). RLP shall encrypt all generated data frames and shall decrypt all received data frames, using the desired encryption mode and following the procedures of 3.1.2.2.1 and 3.1.2.2.2.

- If the EM field of the received frame is set to '01', the BS/MSC requests RLP data encryption, and RLP cannot perform at least one of the specified encryption modes, RLP shall perform the Non-Encrypted Mode RLP initialization/reset procedure (see 3.1.1.1).

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[7]It is anticipated that future revisions of PPP, IP and other protocols may include encryption.

- If the EM field of the received frame is set to '01', but the BS/MSC does not request RLP data encryption, RLP shall perform the Non-Encrypted Mode RLP initialization/reset procedure (see 3.1.1.1).
- If the EM field of the received frame is set to any value other than '01', RLP shall set the most significant bits of EXT_V(R) to zero. In each ACK control frame it then generates, RLP shall set the ENCRYPTION_MODE field to indicate that it does not support encryption and set the EM field to '00'. RLP shall neither encrypt nor decrypt data frames.

When RLP receives an ACK control frame, it shall perform the following:

- If the EM field of the received frame is set to '01', and the BS/MSC requests RLP data encryption, and RLP can perform the specified encryption mode, RLP shall encrypt all generated data frames and shall decrypt all received data frames, using the specified encryption mode and following the procedures of 3.1.2.2.1 and 3.1.2.2.2.
- If the EM field of the received frame is set to '01', the BS/MSC requests RLP data encryption, and RLP cannot perform the specified encryption mode, RLP shall perform the Non-Encrypted Mode RLP initialization/reset procedure (see 3.1.1.1).
- If the EM field of the received frame is set to '01', but the BS/MSC does not request RLP data encryption, RLP shall perform the Non-Encrypted Mode RLP initialization/reset procedure (see 3.1.1.1).
- If the EM field of the received frame is set to any value other than '01', RLP shall neither encrypt nor decrypt data frames.

3.1.2 Data Transfer

When transferring data, RLP is a pure NAK-based protocol. That is, the receiver does not acknowledge correct data frames; it only requests the retransmission of data frames that were not received.

All operations on RLP frame sequence numbers shall be carried out in unsigned modulo 4096 arithmetic. Comparisons of two RLP frame sequence numbers shall also be modulo 4096: for any RLP frame sequence number N, those sequence numbers from (N+1) modulo 4096 to (N+2047) modulo 4096, inclusive, shall be considered greater than N while all sequence numbers from (N-2048) modulo 4096 to (N-1) modulo 4096, inclusive, shall be considered less than N.[8]

RLP shall maintain a 12-bit sequence number count L_V(S) (see Figure 1). RLP shall set the sequence number field (SEQ) in each new data frame, each idle frame, and each control frame to the least significant 8 bits of L_V(S). RLP shall set the L_SEQ_HI field in a NAK control frame to the most significant 4 bits of L_V(S). L_V(S) shall be incremented,

[8]Note that (N-1) modulo 4096 is equal to (N+4095) modulo 4096, and (N-2048) modulo 4096 is equal to (N+2048) modulo 4096.

modulo 4096, after generating each new data frame that contains a non-zero number of data octets. L_V(S) shall not be incremented after generating an idle or control frame.

When RLP generates a new data frame, it shall perform the following:

- If a format B frame is used, RLP shall set the TYPE field as specified for a new data frame (see 4.2.3.2)
- Otherwise, RLP shall set the REXMIT field to '0' and shall not generate segmented data frames.

When RLP generates a retransmitted data frame (in response to a NAK control frame), it shall perform the following:

- If a format B frame is used, RLP shall set the TYPE field as specified for a retransmitted data frame (see 4.2.3.2)
- Otherwise, RLP shall set the REXMIT field to '1'.

When the retransmitted data frame is supplied to the multiplex sublayer, if the size of the retransmitted data frame is less than or equal to the frame size allowed by the multiplex sublayer, an unsegmented data frame (see 4.2.1 and 4.2.3) shall be supplied. If the size of the retransmitted data frame exceeds the frame size allowed by the multiplex sublayer, RLP may segment the retransmitted data frame as specified in 3.1.4.

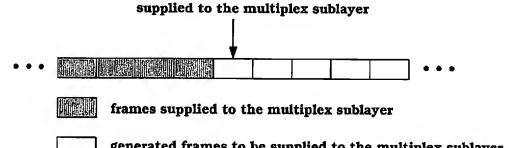

Figure 1 RLP Transmit Sequence Number

RLP shall maintain two 12-bit sequence number variables, L_V(R) and L_V(N) (see Figure 2). L_V(R) contains the expected value of the RLP frame sequence number field in the next data frame to be received. The least significant 8 bits of L_V(R) is denoted by V(R). L_V(N) contains the sequence number of the next needed data frame not received in sequence.

RLP shall process the received RLP frames every 20 ms.[9]

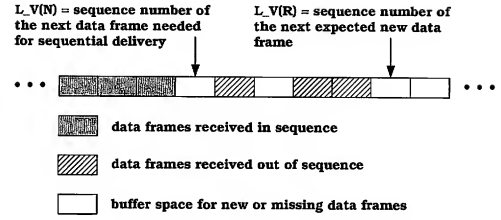

Figure 2 RLP Receive Sequence Number Variables

RLP shall provide two storage buffers for resequencing out-of-sequence data frames. One shall be used for the Forward Traffic Channel, and the other for the Reverse Traffic Channel. Each buffer shall each be able to store no fewer than the number of data frames specified in Table 10, with each frame being the maximum size allowed for the traffic type carrying RLP.

[9] It is conceivable that RLP frames can be delayed between a sending and receiving RLP, such that a group of frames sent together will not be received together. Detecting this is optional. However, procedures are provided for implementations that support delayed RLP frame detection.

Table 10 Minimum Resequencing Storage Buffer Size

Number of Forward Supplemental Code Channels Supported by the Mobile Station	Minimum Number of Data Frames in the Forward Resequencing Storage Buffer	Number of Reverse Supplemental Code Channels Supported by the Mobile Station	Minimum Number of Data Frames in the Reverse Resequencing Storage Buffer
0	89	0	89
1	178	1	178
2	267	2	267
3	356	3	356
4	445	4	445
5	534	5	534
6	623	6	623
7	712	7	712

RLP shall maintain a NAK List. Each NAK List entry contains the 12-bit sequence number of a data frame for which a NAK control frame has been generated, and two associated timers (a NAK retransmission timer and a NAK abort timer). When a retransmitted data frame is received, RLP uses the NAK List to map the 8-bit sequence number of the retransmitted frame to the 12-bit sequence number of the missing data frame.

For each valid received data frame containing a non-zero number of octets, RLP shall form L_SEQ from the SEQ field of the received frame as follows:

- If the received frame is a retransmitted data frame (i.e., the REXMIT field is set to '1' or the TYPE field is set to '011' or '11' in a Rate 1 Format B frame), RLP shall search the NAK List, in order from oldest to newest entry, to find the entry whose least significant bits match the SEQ field of the received frame. RLP shall set L_SEQ to the 12-bit sequence number of the matching NAK List entry. If a matching NAK List entry is not found, RLP shall discard the frame.
- If the received frame is a new data frame (i.e., not a retransmitted data frame), then L_SEQ shall be computed from the following relation:

$$L\_SEQ = (L\_V(R) + [256 + SEQ - V(R)] \bmod 256) \bmod 4096.$$ [10]

RLP shall process the received data frames in ascending order of L_SEQ as follows:

[10] Each 20 ms RLP can receive at most 8 RLP frames; thus L_V(R) can increase at most by 8 each 20 ms. A computed value of L_SEQ that is greater than the maximum number that L_V(R) could have changed indicates that the frame has been delayed. For instance, to detect up to a 40 ms delay, L_SEQ should be compared to the sum of 16 plus the value of L_V(R) 40 ms ago.

- If the received frame is not a retransmitted data frame (i.e., the REXMIT field is set to '0' or the TYPE field is set to '010' or '10' in a Rate 1 Format B frame), then RLP shall perform the following:
  - If RLP identifies the frame as a delayed RLP frame, it shall treat it as if it was a retransmitted data frame.
  - If L_SEQ is equal to L_V(R), then:
    + If L_V(R) is equal to L_V(N), RLP shall increment L_V(N) and L_V(R), modulo 4096, and shall pass all data octets in the data frame to the higher layer.
    + If L_V(R) is not equal to L_V(N), RLP shall increment L_V(R), modulo 4096, and shall store the data frame in the resequencing buffer.
  - If L_SEQ is greater than L_V(R), then:
    + RLP shall create a NAK List entry for each missing data frame from L_V(R) to (L_SEQ-1) modulo 4096, inclusive. Each NAK List entry shall contain the sequence number of one of the missing data frames.
    + RLP shall store the data frame in the resequencing buffer and set L_V(R) to (L_SEQ + 1) modulo 4096.
- If the received frame is a retransmitted data frame (i.e., the REXMIT field is set to '1' or the TYPE field is set to '011' or '11' in a Rate 1 Format B frame), then RLP shall perform the following:
  - If L_SEQ is less than L_V(N), RLP shall discard the frame.
  - If L_SEQ is greater than or equal to L_V(R), RLP shall discard the frame.
  - If L_SEQ is greater than or equal to L_V(N) and less than L_V(R), then:
    + If the received frame is a segmented data frame, RLP shall perform reassembly as specified in 3.1.4. If, after reassembly, a complete data frame is available, the assembled data frame shall be treated as a retransmitted unsegmented data frame.
    + If the received frame is an unsegmented data frame, RLP shall store the data frame in the resequencing buffer. If L_SEQ is equal to L_V(N), RLP shall pass to the higher layer, in sequence number order, all data octets in all contiguous data frames in the resequencing buffer, from L_V(N) upward. RLP shall then set L_V(N) to (LAST + 1) modulo 4096, where LAST is equal to the sequence number of the last data frame whose data octets were passed to the higher layer.

For each valid received idle frame, RLP shall compute L_SEQ from the following relation:

$$L\_SEQ = (L\_V(R) + [256 + SEQ - V(R)] \bmod 256) \bmod 4096.$$[11]

[11] Each 20 ms RLP can receive at most 8 RLP frames; thus L_V(R) can increase at most by 8 each 20 ms. A computed value of L_SEQ that is greater than the maximum number that L_V(R) could

- If RLP identifies the frame as a delayed RLP frame, it shall discard the frame.
- If L_SEQ is greater than L_V(R), RLP shall create a NAK List entry for each missing data frame from L_V(R) to (L_SEQ-1) modulo 4096, inclusive. Each NAK List entry shall contain the sequence number of one of the missing data frames. RLP shall then set L_V(R) to L_SEQ.

For each valid received NAK control frame, RLP shall compute L_SEQ from the following relation:

$$L\_SEQ = (SEQ + (L\_SEQ\_HI \times 256)).$$

- If L_SEQ is greater than L_V(R), RLP shall create a NAK List entry for each missing data frame from L_V(R) to (L_SEQ-1) modulo 4096, inclusive. Each NAK List entry shall contain the sequence number of one of the missing data frames. RLP shall then set L_V(R) to L_SEQ.
- If L_SEQ is less than L_V(R) and RLP has determined that frames are not being delayed, RLP shall perform the initialization/reset procedures specified in 3.1.1.1 or 3.1.1.2.
- RLP shall generate a copy of each requested data frame as a retransmitted data frame. If the NAK requests any sequence number greater than or equal to L_V(S),[12] RLP shall perform the initialization/reset procedures specified in 3.1.1.1 or 3.1.1.2.

After processing the received RLP frames, RLP shall process the NAK List entries as follows:

- If the received RLP frames included a valid idle frame or a valid new data frame, RLP shall perform the following for each entry for which RLP has included the missing data frame's sequence number in a NAK control frame:
  - If the entry's abort timer has been set but has not expired , RLP shall decrement the entry's abort timer. If this causes the timer to expire (i.e., its value reaches 0), RLP shall perform the following:
    + If RLP has received a retransmitted frame for the entry, RLP shall remove the entry from the NAK List.
    + If RLP has not received a retransmitted frame for the entry, RLP shall set L_V(N) to the sequence number of the next missing data frame, or to L_V(R) if there are no other missing data frames. RLP shall then pass to the higher layer, in sequence number order, all data octets in all contiguous data frames in the resequencing buffer whose sequence number is greater than

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have changed indicates that the frame has been delayed. For instance, to detect up to a 40 ms delay, L_SEQ should be compared to the sum of 16 plus the value of L_V(R) 40 ms ago.

[12] This would indicate that the NAK process has fallen behind the sequence numbering by more than 2048 frames.

the missing data frame's sequence number and less than L_V(N). RLP shall then remove this entry.

- If the entry's retransmission timer has been set but has not expired , RLP shall decrement the entry's retransmission timer. If this causes the timer to expire (i.e., its value reaches 0), RLP shall perform the following:
  - + If RLP has received a retransmitted frame for the entry, RLP shall remove the entry from the NAK List.
  - + If RLP has not received a retransmitted frame for the entry, RLP shall include the missing data frame's sequence number in three NAK control frames. After sending the last NAK control frame, RLP shall set the entry's abort timer to an implementation dependent value greater than RLP_DELAY_s[13].

- If an entry is a new NAK List entry (i.e., RLP has not yet included the missing data frame's sequence number in a NAK control frame), RLP shall perform the following:
  - If RLP has determined that RLP frames are being delayed, RLP should defer including the missing data frame's sequence number in a NAK control frame for an implementation dependent time, anticipating that the missing frame will arrive during that time.
  - If RLP has received a delayed frame for the entry, RLP shall remove the entry from the NAK List.
  - Otherwise, RLP shall include the missing data frame's sequence number in two NAK control frames. After sending the last NAK control frame, RLP shall set the entry's retransmission timer to an implementation dependent value greater than RLP_DELAY_s[13].

Every 20 ms, if RLP supplies any non-blank RLP frame to the multiplex sublayer, RLP shall reset the idle timer to an implementation dependent value greater than RLP_DELAY_s[13] and set the idle frame transmission counter to 0. Otherwise, RLP shall decrement the idle timer. If this causes the idle timer to expire (i.e., its value reaches 0), RLP shall generate a control frame or an idle frame[14], shall reset the idle timer to an implementation dependent value greater than RLP_DELAY_s, and shall increment the idle frame transmission counter. When the idle frame transmission counter reaches 3, the idle timer shall be disabled.

3.1.2.1 Encryption

When RLP data encryption is negotiated, the Data octets of all generated data frames shall be encrypted, using the following procedures.

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[13]It is recommended that this value be no less than 5, to account for buffering within the mobile and base station, and for possible segmentation of the retransmitted data frame.

[14]When RLP frames are carried as secondary traffic, an RLP idle frame is an RLP data frame with zero length (see 4.3.2.1).

Encryption mask generation shall be in accordance with the Data_Mask procedure defined in "Common Cryptographic Algorithms, Revision A.1." When a data frame is generated, RLP shall set the input parameters of the Data_Mask procedure, HOOK and LEN (see "Interface Specification for Common Cryptographic Algorithms, Revision A.1") as follows:

- If the data frame is generated by a mobile station, RLP shall set HOOK equal to EXT_V(S) (see 3.1.1.2.1), with the two most significant bits of HOOK set to '00'.
- If the data frame is generated by a BS/MSC, RLP shall set HOOK equal to EXT_V(S) (see 3.1.1.2.1), and shall then set the most significant bits of HOOK to '01'.
- The length of the mask (LEN) shall be equal to the number of octets in the Data part of the data frame.

RLP shall then execute the Data_Mask procedure.

Each octet of the Data part of the data frame shall be combined with the mask by bitwise exclusive-or, combining successive data octets with mask octets.

Retransmitted data frames shall be encrypted using the same mask as when first generated(i.e., each data octet in a retransmitted data frame shall have the same encrypted value as when originally encrypted).

Retransmitted data frames shall be encrypted prior to segmentation.

3.1.2.2 Decryption

For each data frame received, RLP shall form an extended sequence number EXT_SEQ whose most significant 18 bits shall be set to the most significant bits of EXT_V(R) (see 3.1.1.2.1) and whose least significant 12 bits shall be set to L_SEQ.

When an encrypted data frame is received, RLP shall set the input parameters of the Data_Mask procedure (see "Interface Specification for Common Cryptographic Algorithms, Revision A.1") as follows:

- If the data frame is received from a mobile station, RLP shall set HOOK equal to EXT_SEQ, with the two most significant bits of HOOK set to '00'.
- If the data frame is received from a BS/MSC, RLP shall set HOOK equal to EXT_SEQ, and shall then set the most significant bits of HOOK to '01'.
- The length of the mask (LEN) shall be equal to the number of octets in the Data part of the data frame.

RLP shall then execute the Data_Mask procedure.

Each octet of the Data part of the data frame shall be combined with the mask by bitwise exclusive-or, combining successive data octets with mask octets.

Segmented frames shall be reassembled prior to decrypting the data.

3.1.3 Frame Validity Checks

3.1.3.1 Primary Traffic

When RLP frames are carried as primary traffic, RLP shall discard as invalid any received frame for which any of the following applies:

1. If the frame is a Fundamental RLP frame and either RLP is used with Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15, and the multiplex sublayer classifies the frame as category 3, 7, 9, 10 or 12, or RLP is used with Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16 and the multiplex sublayer classifies the frame as category 26.. RLP shall count the frame as an "erasure"[15].

2. If the frame is a Supplemental RLP frame and RLP is used with Multiplex Option 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16 and the multiplex sublayer classifies the frame as category 3. RLP shall count the frame as an "erasure"[15].

3. For a control frame, if the FCS field does not check. For a Rate 1/8 or Rate 1/16 intersegment fill frame or for a Rate 1/8 idle frame, if the FCS field is not the correct value for the value of the SEQ field. RLP shall count the frame as an "erasure"[15].

4. If the frame's TYPE field value is not one of the values defined in 4.

5. If the frame's LEN field value is not within the range allowed in 4.

6. If the frame's CTL field value is not a value defined in 4.

7. For Rate 1/8 and Rate 1/16 frames, L_SEQ is not within the range from L_V(R) to (L_V(R)+E) modulo 4096, inclusive, where E is a count of the number of consecutive frames RLP has counted as "erasures"[15].

All other received frames shall be considered valid.

If three consecutive identical Rate 1/8 frames arrive that are considered invalid as defined in (7) above, then:

- If L_SEQ is greater than L_V(R), RLP shall consider the third frame to be valid and shall process it as specified in 3.1.2.
- If L_SEQ is less than L_V(R), RLP shall perform the initialization/reset procedure specified in 3.1.1.1 or 3.1.1.2.

RLP shall maintain a count E of the number of consecutive frames classified as "erasures"[15]. When E exceeds 255, RLP shall perform the initialization/reset procedure specified in 3.1.1.1 or 3.1.1.2.

3.1.3.2 Secondary Traffic

When RLP frames are carried as secondary traffic, RLP shall discard as invalid any received frame for which any of the following applies:

1. If the frame is a Fundamental RLP frame and either RLP is used with Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15, and the multiplex sublayer classifies the frame

[15] The "erasures" defined here help determine when RLP should perform initialization/reset. They should not be confused with TIA/EIA-95 frame erasures.

as category 10, or RLP is used with Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16 and the multiplex sublayer classifies the frame as category 26. RLP shall count the frame as an "erasure"[15].

2. If the frame is a Supplemental RLP frame and RLP is used with Multiplex Option 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16 and the multiplex sublayer classifies the frame as category 3. RLP shall count the frame as an "erasure"[15].

3. For a control frame, if the FCS field does not check. For a Rate 1/8 or Rate 1/16 intersegment fill frame, if the FCS field is not the correct value for the value of the SEQ field. RLP shall count the frame as an "erasure"[15].

4. If the RLP frame's TYPE field value is not one of the values defined in 4.

5. If the RLP frame's LEN field value is not within the range allowed in 4.

6. If the RLP frame's CTL field value is not a value defined in 4.

All other received frames shall be considered valid.

RLP shall maintain a count E of the number of consecutive frames classified as "erasures"[15] as defined in (1), (2), and (3) above. When E exceeds 255, RLP shall perform the initialization/reset procedure specified in 3.1.1.1 or 3.1.1.2.

3.1.4 Segmentation of Retransmitted Data Frames

The following procedures apply to the segmentation and reassembly of data frames. Segmentation may be necessary when a retransmitted data frame's size exceeds the frame size allowed by the multiplex sublayer when the retransmitted data frame is supplied to the multiplex sublayer. Segmented data frames are sent only as Fundamental RLP frames.

RLP procedures below assure that no more than three data bearing segments are needed to retransmit a data frame by requiring all but the last segment to use at least a Rate 3/8 frame.[16]

A retransmitted data frame may be supplied in one, two or three segments. If the retransmitted data frame is supplied in a single segment, an unsegmented frame (see 4.2.1 and 4.2.3) is used. If the retransmitted data frame's size exceeds the frame size allowed by the multiplex sublayer when the retransmitted data frame is supplied to the multiplex sublayer, RLP should segment the frame. With the exception of intersegment fill frames, all RLP segmented data frames except the last segmented data frame shall be supplied using Rate 3/8 or larger RLP frames.

When Rate Set 2 is used, an intersegment fill frame (see 4.2.2.1) can be supplied by the BS/MSC. When the intersegment fill frame is used the sequence number of an

[16]For Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15, the smallest available frame that carries data is Rate 1/2, which is larger than Rate 3/8.

intersegment fill frame shall be set equal to the sequence number of the data frame being retransmitted.

RLP segments the frame using the following procedure:

- The first segment shall be generated using the First Segment frame type (see 4.2.2). The segment should contain the maximum number of data octets that can fit in the frame size allowed by the multiplex sublayer. If RLP is used with Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16 and less than a Rate 3/8 RLP frame is allowed, RLP shall perform the following:
  - If RLP cannot supply a Supplemental RLP frame to the multiplex sublayer, a Blank RLP frame should be supplied to the multiplex sublayer as the Fundamental RLP frame. Alternately, an intersegment fill frame (see 4.2.2.1) may be supplied.
  - If RLP can supply a Supplemental RLP frame to the multiplex sublayer, RLP should not begin segmentation of the data frame being retransmitted.
- After supplying a First Segment frame type, if the data frame's size needed to contain the remaining data octets exceeds the frame size allowed by the multiplex sublayer at the time the frame is supplied to the multiplex sublayer, RLP shall perform the following:
  - If RLP cannot supply a Supplemental RLP frame to the multiplex sublayer, the next segment shall be generated using the Second Segment frame type (see 4.2.2). The segment should contain the maximum number of data octets that can fit in the frame size allowed by the multiplex sublayer. If RLP is used with Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16 and less than a Rate 3/8 RLP frame is allowed, a Blank RLP frame should be supplied to the multiplex sublayer as the Fundamental RLP frame. Alternately, an intersegment fill frame (see 4.2.2.1) may be supplied.
  - If RLP can supply a Supplemental RLP frame to the multiplex sublayer, RLP should abort segmentation of the data frame being retransmitted. RLP should supply the entire data frame being retransmitted as a Supplemental RLP frame.
- After supplying a First or Second Segment frame type, if the data frame's size needed to contain the remaining data octets is less than or equal to the frame size allowed by the multiplex sublayer at the time the frame is supplied to the multiplex sublayer, the next segment shall be generated using the Last Segment frame type (see 4.2.2).
- After supplying a Second Segment frame type, if RLP is used with Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16 and the data frame's size needed to contain the remaining data octets exceeds the frame size allowed by the multiplex sublayer at the time the frame is supplied to the multiplex sublayer, a Blank RLP frame should be supplied to the multiplex sublayer. Alternately, an intersegment fill frame (see 4.2.2.1) may be supplied.
- Segmented data frames shall not be supplied with the LEN field equal to zero.

- The SEQ field of each segment shall be set to the least significant 8 bits of the sequence number of the data frame being retransmitted.
- RLP may supply control frames between segments of a segmented data frame. If RLP is used with Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15, RLP may supply Rate 1/8 idle frames (see 4.3) between segments of a segmented data frame. If RLP is used with Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16, RLP shall not supply Fundamental RLP idle frames between segments of a segmented data frame. RLP shall not supply other Fundamental data frames nor a segment with a different sequence number between segments of a segmented data frame.

RLP shall begin frame reassembly on receipt of the first segment of a segmented data frame. When RLP is used with Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16, if RLP receives a valid an intersegment fill frame, RLP shall discard it. When RLP receives the last segment of the data frame, RLP shall process the data frame in the same manner as if it had been unsegmented.

RLP shall discard, without further processing, any segmented data frame that is received under any of the following conditions:

- If a segment is received out of order (e.g., a last or second segment received without receiving a first segment).
- If an invalid Fundamental frame (see 3.1.3) is received at any time between the first and last segments.
- If a Fundamental data frame or segment with a different sequence number is received between the first and last segments.[17]
- When RLP is carried using Multiplex Option 2, if an idle frame (see 4.3) is received at any time between the first and last segments.

[17] When a Supplemental frame with a different sequence number is received within the same 20 ms slot as a First or Last segment, the Supplemental frame shall not be discarded.

4 RLP FRAME FORMATS

For RLP control frames, RLP shall use the formats defined in 4.1.

For Fundamental RLP data frames whose rate is less than Rate 1, RLP shall use the formats in 4.2.1 or 4.2.2. For Rate 1 Fundamental or Supplemental RLP data frames, RLP shall use the formats in 4.2.3.

For idle frames, RLP shall use the format in 4.3.

4.1 Control Frames

Control frames are distinguished by the CTL field.

Control frames shall contain the least significant 8 bits of L_V(S), in order that missing data frames may be quickly detected. RLP shall not increment L_V(S) after generating a control frame.

4.1.1 SYNC, SYNC/ACK, and ACK Control Frames

SYNC, SYNC/ACK, and ACK control frames are used during RLP initialization.

Field	Length (bits)
SEQ	8
CTL	6
ENCRYPTION_MODE	2
EM	0 or 2
EXT_SEQ_M	0 or 18
Padding_1	Variable
FCS	16
Padding_2	Variable

SEQ - Data frame sequence number.

CTL - RLP frame type. For SYNC, SYNC/ACK, and ACK control frames, the CTL field is defined as follows:

'1101 10' - SYNC. Requests return of a control frame with the ACK bit set.

'1110 10' - ACK. Acknowledges receipt of a control frame with the SYNC bit set.

'1111 10' - SYNC/ACK. Indicates both SYNC and ACK.

ENCRYPTION_MODE - Encryption Mode.

This field indicates the supported or desired user data encryption mode(s), set according to Table 11.

EM - Encryption Request Indicator.

'00' (Default) Requests or Acknowledges no RLP data frame encryption (not supported or inactive).

'01' Requests or Acknowledges RLP data frame encryption capability.

EXT_SEQ_M - This field shall be included when the EM field is included.

When the EM field is set to '01', this field shall be set to the 18 most significant bits of EXT_V(S) (see 3.1.1.2.1). Otherwise, this field shall be set to all zeros.

Padding_1 - Padding bits. As required to octet align the FCS field. These bits shall be set to '0'.

FCS - Frame Check Sequence. The contents shall be as generated by the 16-bit FCS polynomial specified in 3.1 of RFC 1662. The FCS shall cover all fields before the FCS field.

Padding_2 - Padding bits. As required to fill the remainder of the frame. These bits shall be set to '0'.

Table 11 User Data Encryption Modes

Encryption Mode (binary)	Meaning
00	Encryption not supported (default).
01	Enhanced encryption mode
10	Both basic and enhanced encryption modes. This value shall not be used in ACK control frames.
11	Basic encryption mode.

4.1.2 NAK Control Frame

A NAK control frame requests the retransmission of one or more data frames.

Field	Length (bits)
SEQ	8
CTL	6
NAK_TYPE	2
L_SEQ_HI	4

If NAK_TYPE = '00', the following fields shall be:

FIRST	12
LAST	12

If NAK_TYPE = '01', the following fields shall be:

NAK_Map_Count	2

NAK_Map_Count + 1 occurrences of the following record:

NAK_Map_SEQ	12
NAK_Map	8

For any NAK_TYPE value, the following fields shall be:

Padding_1	Variable
FCS	16
Padding_2	variable

SEQ - Data frame sequence number.

CTL - '1100 00' - NAK. Requests retransmission of data frames.

NAK_TYPE - NAK type, as defined below:

'00' - Requests retransmission of data frames numbered FIRST through LAST, inclusive.
'01' - Requests retransmission of data frames as specified by the NAK Map(s).

L_SEQ_HI - The most significant 4 bits of L_V(S).

FIRST - The 12-bit sequence number of the first data frame for which retransmission is requested.

LAST - The 12-bit sequence number of the last data frame for which retransmission is requested.

Padding_1 - Padding bits. As required to octet align the FCS field. These bits shall be set to '0'.

FCS - Frame Check Sequence. The contents shall be as generated by the 16-bit FCS polynomial specified in 3.1 of RFC 1662. The FCS shall cover all fields before the FCS field.

Padding_2 - Padding bits. As required to fill the remainder of the frame. These bits shall be set to '0'.

NAK_Map_Count - One less than the number of NAK Maps in this NAK control frame.

NAK_Map_SEQ - The 12-bit sequence number of the first data frame for which retransmission is requested.

NAK_Map - A bitmap identifying additional missing data frames for which retransmission is requested. The most significant bit corresponds to the data frame identified by (NAK_Map_SEQ +1) modulo 4096. Each less significant bit corresponds to the next sequential data frame. A bit set to '1' indicates that the corresponding data frame is missing.

4.2 Data Frames

4.2.1 Unsegmented Data Frames

Unsegmented data frames carry a variable number of data octets, using a length field to indicate the number of octets.

Field	Length (bits)
SEQ	8
CTL	1
REXMIT	1
LEN	6
Data	8xLEN
Padding	Variable

SEQ - Data frame sequence number. See 3.1.2.

CTL - For a frame carrying unsegmented data the CTL field shall be set to '0'.[18]

REXMIT - Retransmitted frame indicator. This bit is set to '1' when the frame is a retransmitted data frame. Otherwise, it is set to '0'.

LEN - Data length. May be any value in the range from 0 to the maximum allowable for the data frame. Maximum values of LEN (MAX_LEN) are given in Table 12.

When LEN is zero, the frame is treated as an idle frame.

Data - Data octets.

[18]Note that the most significant bit of the CTL field of a control frame and a segmented data frame is always set to '1'.

Padding - Padding bits. As required to fill the remainder of the frame. These bits shall be set to '0'.

Table 12 Values of the Maximum Allowable Data Length (MAX_LEN

RLP Frame Type	MAX_LEN Multiplex Options 1, 3, 5, 7, 9, 11, 13, and 15	MAX_LEN Multiplex Options 2, 4, 6, 8, 10, 12, 14, and 16
Primary Traffic		
Rate 1 (Format A, see 4.2.3.1.1)	19	31
Rate 1/2	8	13
Rate 1/4	Not Used	4
Secondary Traffic		
Rate 1 (Format A, see 4.2.3.1.2)	19	30
Rate 7/8	17	28
Rate 3/4	14	24
Rate 1/2	9	15
Rate 7/16	N/A	13
Rate 3/8	N/A	10
Rate 1/4	Not Used	6
Rate 3/16	N/A	4

4.2.2 Segmented Data Frames

Segmented data frames carry a variable number of data octets, using a length field to indicate the number of octets. This type of data frame shall only be used to carry retransmitted data frames (see 3.1.4).

Field	Length (bits)
SEQ	8
CTL	4
LEN	0 or 4
Data	0 or 8xLEN
Padding	Variable

SEQ - Data frame sequence number. See 3.1.4.

CTL - For segmented data frames, the CTL field is defined as follows:

'1000' - First Segment. Contains the first LEN octets of the segmented data frame.

'1001' - Second Segment. Contains the next LEN octets of the segmented data frame.

'1010' - Last Segment. Contains the last LEN octets of the segmented data frame.

'1011' - Intersegment Fill Frame. When Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16 is used, intersegment fill frames can be sent before or between segmented data frames (see 3.1.4). Intersegment fill frames are not used with Multiplex Option 1, 3, 5, 7, 9, 11, 13, or 15.

LEN - Data length. When CTL is set to '1000', '1001', or '1010', the LEN field may be any value in the range from 1 to the maximum allowable for the data frame, or 15, whichever is less. Values of the maximum allowable data length (MAX_LEN) are given in Table 12. When CTL is set to '1011' the LEN field shall not be included.

Data - Data octets. When CTL is set to '1000', '1001', or '1010', this field shall carry LEN Data octets. When CTL is set to '1011' the Data field shall not be included.

Padding - Padding bits. As required to fill the remainder of the frame. These bits shall be set to '0'.

4.2.2.1 Rate 1/8 and Rate 1/16 Intersegment Fill Frames

For Multiplex Option 2, 4, 6, 8, 10, 12, 14, or 16, Rate 1/8 primary traffic RLP frames and Rate 1/16 secondary traffic RLP frames may be intersegment fill frames.

Field	Length (bits)
SEQ	8
FCS	8
ISF	4

SEQ - Data frame sequence number. See 3.1.4.

FCS - Frame Check Sequence. This field is identical to the FCS field of an idle frame with matching SEQ field. See 4.3.

ISF - Intersegment Fill frame indicator. The value '1111' indicates an intersegment fill frame.

4.2.3 Rate 1 RLP Frames

For Rate 1 RLP data frames, two special frame formats are used. Format A RLP data frames are described in 4.2.3.1. Format B RLP data frames are described in 4.2.3.2.

4.2.3.1 Rate 1 RLP Frame Format A

4.2.3.1.1 Format A for Primary Traffic

When RLP frames are carried as primary traffic by Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15, a format A frame is defined as follows:

Field	Length (bits)
Information	168
TYPE	3

Information - Control or data frame. Formatted according to the control and data frame formats described in 4.1, 4.2.1 and 4.2.2.

TYPE - Frame type. The TYPE field shall be set to '001'.

When RLP frames are carried as primary traffic by Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16, a format A frame is defined as follows:

Field	Length (bits)
Information	264
TYPE	2

Information - Control or data frame. Formatted according to the control and data frame formats described in 4.1, 4.2.1 and 4.2.2.

TYPE - Frame type. The TYPE field shall be set to '01'.

4.2.3.1.2 Format A for Secondary Traffic

When RLP frames are carried as secondary traffic by Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15, a format A frame is defined as follows:

Field	Length (bits)
Information	165
TYPE	3

Information - Control or data frame. Formatted according to the control and data frame formats described in 4.1, 4.2.1 and 4.2.2.

TYPE - Frame type. The TYPE field shall be set to '001'.

When RLP frames are carried as secondary traffic by Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16, a format A frame is defined as follows:

Field	Length (bits)
Information	260
TYPE	2

Information - Control or data frame. Formatted according to the control and data frame formats described in 4.1, 4.2.1 and 4.2.2.

TYPE - Frame type. The TYPE field shall be set to '01'.

4.2.3.2 Rate 1 RLP Data Frame Format B

4.2.3.2.1 Format B for Primary Traffic

When RLP frames are carried as primary traffic by Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15, a format B frame is defined as follows:

Field	Length (bits)
SEQ	8
Data	160
TYPE	3

SEQ - Data frame sequence number. See 3.1.2 and 3.1.4.

Data - Data octets. This field shall contain 20 octets of data.

TYPE - Frame type. The TYPE field is set to '010' for a new data frame and set to '011' for a retransmitted data frame.

When RLP frames are carried as primary traffic by Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16, a format B frame is defined as follows:

Field	Length (bits)
SEQ	8
Data	256
TYPE	2

SEQ - Data frame sequence number. See 3.1.2 and 3.1.4.

Data - Data octets. This field shall contain 32 octets of data.

TYPE - Frame type. The TYPE field is set to '10' for a new data frame and set to '11' for a retransmitted data frame.

4.2.3.2.2 Format B for Secondary Traffic

When RLP frames are carried as secondary traffic by Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15, a format B frame is defined as follows:

Field	Length (bits)
SEQ	8
Data	152
TYPE	8

SEQ - Data frame sequence number. See 3.1.2 and 3.1.4.

Data - Data octets. This field shall contain 19 octets of data.

TYPE - Frame type. The TYPE field is set to '00000010' for a new data frame and set to '00000011' for a retransmitted data frame.

When RLP frames are carried as primary traffic by Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16, a format B frame is defined as follows:

Field	Length (bits)
SEQ	8
Data	248
TYPE	6

SEQ - Data frame sequence number. See 3.1.2 and 3.1.4.

Data - Data octets. This field shall contain 31 octets of data.

TYPE - Frame type. The TYPE field is set to '000010' for a new data frame and set to '000011' for a retransmitted data frame.

4.3 Idle Frames

For Multiplex Option 1, 3, 5, 7, 9, 11, 13, and 15, Rate 1/8 RLP frames are idle frames. For Multiplex Option 2, 4, 6, 8, 10, 12, 14, and 16, Rate 1/8 primary traffic RLP frames and Rate 1/16 secondary traffic RLP frames may be idle frames. Higher rate RLP data frames with zero length (LEN = 0) (see 4.2.1) are also idle frames.

Field	Length (bits)
SEQ	8
FCS	8
Padding	0 or 4

SEQ - Data frame sequence number. See 3.1.2.

FCS - Frame Check Sequence based on a modified Nordstrom-Robinson code.

Let the sequence number to be coded be denoted as $(X_7 X_6 X_5 X_4 X_3 X_2 X_1 X_0)$

Let the FCS be denoted as $(Y_7 Y_6 Y_5 Y_4 Y_3 Y_2 Y_1 Y_0)$

The FCS is generated as follows:

$$Y_0 = X_7 \oplus X_6 \oplus X_0 \oplus X_1 \oplus X_3 \oplus (X_0 \oplus X_4)\cdot(X_1 \oplus X_2 \oplus X_3 \oplus X_5) \oplus (X_1 \oplus X_2)\cdot(X_3 \oplus X_5)$$

Where $\oplus$ denotes modulo-2 addition. Code bits Y_1 through Y_6 are found by cyclically shifting X_0 through X_6. In other words, $X_{((i-j) \bmod 7)}$ is substituted for X_i in the generating equation for Y_j. Y_7 is a parity bit over the previous 15 bits. The final step in generating the FCS is to complement the last three bits. A table specifying the code is provided in Table 13.

Pad - Padding bits. As required to fill the remainder of the frame. These bits shall be set to '0'.

Table 13 presents the modified Nordstrom-Robinson code used to protect Rate 1/8 and Rate 1/16 idle frames. In Table 13, the most significant byte in a word is the SEQ value to be protected and the least significant byte is the FCS. All numbers are hexadecimal.

Table 13 Modified Nordstrom-Robinson Code

0007	20f3	40ee	6034	8078	a08c	c091	e04b
01d4	2119	4161	6182	81ab	a166	c11e	e1fd
02a0	226d	423b	62d8	82df	a212	c244	e2a7
034a	23be	438d	6357	8335	a3c1	c3f2	e328
04c9	242a	4452	649f	84b6	a455	c42d	e4e0
057f	25a5	45b8	654c	8500	a5da	c5c7	e533
061c	26c6	46f5	6601	8663	a6b9	c68a	e67e
0793	2770	4726	67eb	87cc	a70f	c759	e794
089a	2840	485d	68a9	88e5	a83f	c822	e8d6
092c	29cf	49b7	697a	8953	a9b0	c9c8	e905
0a76	2a95	4ac3	6a0e	8a09	aaea	cabc	ea71
0bf9	2b23	4b10	6be4	8b86	ab5c	cb6f	eb9b
0c31	2cfc	4c84	6c67	8c4e	ac83	ccfb	ec18
0de2	2d16	4d0b	6dd1	8d9d	ad69	cd74	edae
0eaf	2e5b	4e68	6eb2	8ed0	ae24	ce17	eecd
0f45	2f88	4fde	6f3d	8f3a	af7	cfa1	ef42
10bd	305e	5008	70c5	90c2	b021	d077	f0ba
1132	31e8	51db	712f	914d	b197	d1a4	f150
1251	328b	5296	7262	922e	b2f4	d2e9	f21d
13e7	3304	537c	73b1	9398	b37b	d303	f3ce
1464	3490	54a3	7479	941b	b4ef	d4dc	f406
158e	3543	5515	75f6	95f1	b53c	d56a	f589
16fa	3637	564f	76ac	9685	b648	d630	f6d3
1729	37dd	57c0	771a	9756	b7a2	d7bf	f765
186b	38a6	58f0	7813	9814	b8d9	d88f	f86c
1981	3975	5946	799c	99fe	b90a	d939	f9e3
1acc	3a38	5a25	7aff	9ab3	ba47	da5a	fa80
1b1f	3bd2	5baa	7b49	9b60	bbad	dbd5	fb36
1cd7	3c0d	5c3e	7cca	9ca8	bc72	dc41	fcb5
1d58	3dbb	5ded	7d20	9d27	bdc4	dd92	fd5f
1e02	3ee1	5e99	7e54	9e7d	be9e	dee6	fe2b
1fb4	3f8c	5f73	7f87	9fcb	bf11	df0c	fff8